3 IDENTIFY INPUTS TO THE DECISION

3.1 Introduction

The guidance in this chapter identifies sources of information needed to evaluate the disposition option, or options, selected during the IA. During implementation of an existing SOP, this information would have been considered during development of the SOP. This chapter discusses factors affecting the selection of survey units, provides guidance on defining spatial and temporal boundaries, and examines practical constraints on collecting data. The expected output from this chapter is a decision rule, or multiple decision rules. A decision rule is a theoretical "if...then..." statement that defines how the decision maker would choose among alternative actions if the true state of nature could be known with certainty (EPA 2006a).

There are three parts to a decision rule (Section 3.7):

- An action level that causes a decision maker to choose between the alternative actions (Section 3.3),
- A parameter of interest that is important for making decisions about the target population (Section 3.4), and
- Alternative actions that could result from the decision (Section 3.5).

Other inputs to the decision discussed in this chapter include selecting radionuclides or radiations of concern (Section 3.2), developing survey unit boundaries (Section 3.6), inputs for selecting provisional measurement methods (Section 3.8), and identifying reference material (Section 3.9). Also discussed in this chapter is the evaluation of an existing survey design to determine if it will meet the DQOs (Section 3.10).

This chapter provides guidance on performing Step 3, Step 4, and Step 5 of the DQO Process (EPA 2006a) for designing a disposition survey. These steps build on the IA where members of the planning team were identified and M&E under investigation were identified as impacted (non-impacted M&E do not require additional investigation). A conceptual model of the disposition problem was developed (or SOP selected or developed, see Section 2.6) and a disposition option selected (Section 2.5).

It is important to remember the DQO Process is an iterative process. This means new information can be incorporated into the planning process and outputs from previous steps can be modified to incorporate the new information. For example, if no measurement methods are identified in Section 3.8 that meet the data requirements for a specific disposition option, the planning team may return to Section 2.5 to select a different disposition option. Alternatively, the selection of an action level or survey unit boundary may be affected by the available measurement techniques. The issues associated with surficial vs. volumetric radioactivity (see Section 2.4.2) affect the kinds of information (i.e., action level, survey unit identification, and measurement techniques) as well as the definition of study boundaries (i.e., target population, spatial boundaries, practical constraints on collecting data, subpopulation for which separate decisions will be made).

At the end of this chapter the planning team should have the information required to design the disposition survey and know whether appropriate measurement techniques are available. Spatial and temporal boundaries will be identified, along with any practical constraints on data collection activities. Examples of practical constraints on data collection include time, budget, personnel, or equipment. For example, a box counter is selected to perform measurements for clearance of items from a radiologically controlled area. Assume a five-minute count time is required to achieve the survey objectives, and another minute is required to swap items in the detector. This means that ten measurements can be performed each hour. More than 240 items requiring clearance each day would be a practical constraint on data collection, since a single box counter cannot clear all of the M&E. The decision rule(s) developed at the end of this chapter will be used to develop survey designs in Chapter 4.

3.2 Select Radionuclides or Radiations of Concern

A list of radionuclides of potential concern was developed in Section 2.4.2.1 as part of the description of radiological attributes associated with the M&E. Before a decision rule can be developed or a disposition survey designed, a final list of radionuclides or radiations to be measured must be prepared.

The selection of radionuclides or radiations of concern is linked to several inputs to the decision. For example, the identification of an action level (see Section 3.3) may determine if the survey results need to be radionuclide-specific, forcing the planning team to identify individual radionuclides of concern. On the other hand, the selection of a non-radionuclide specific measurement method may allow the selection of a radiation of concern (i.e., alpha (α), beta (β), gamma (γ), x-ray, or neutron radiation) without ever finalizing a list of radionuclides of concern.

Finalizing the list of radionuclides or radiations of concern is an example of the iterative nature of the survey design process. The planning team is expected to evaluate different survey techniques and measurement methods. Evaluating these different survey techniques and measurement methods will require the planning team to return to the list of radionuclides of potential concern and go through the selection of radionuclides or radiations of concern. The final selection of radionuclides or radiations of concern may not occur until development of a plan for obtaining data in Step 7 of the DQO Process (see Section 4.4.4).

3.3 Identify Action Levels

The action level is the numerical value or values that cause a decision maker to choose one of the alternative actions. The radionuclides of concern and disposition options selected at the completion of the IA define the alternative actions for the disposition survey.

Figure 3.1 shows the process for selecting action levels. As shown in this figure, the iterative nature of the DQO Process may result in changes to the action levels or disposition options based on other factors (e.g., availability of appropriate measurement techniques, measurability, surficial vs. volumetric activity). The planning team should consider the effect of action levels on other steps in the survey design process, as well as any effects these other steps might have on the action levels.

Action levels are radionuclide- or radiation-specific and in units of concentration or activity (e.g., Bq/kg of ^{137}Cs, Bq/m^2 of alpha radiation, Bq of ^{60}Co). Action levels may be provided, derived from dose- or risk-based standards, or converted into more convenient units for a specific measurement technique.[1] More than one action level may be required to demonstrate compliance with a specific standard. For example, DOE Order 5400.5 Figure IV-1 (DOE 1993) provides limits for average total surface activity, maximum total surface activity, and average removable surface activity (see Appendix E). All three limits must be achieved to demonstrate compliance for disposition of the M&E. Sometimes multiple regulatory requirements may apply, for example transportation regulations combined with waste acceptance criteria and health protection standards.

Action levels may be established based on total activity or incremental activity levels relative to background. Examples of incremental action levels include activity levels based on dose or risk above background, or interdiction at some multiple above background. For these types of action levels it is important to establish a representative reference material (see Section 3.9) for comparison.

At this point it is important to identify action levels appropriate for the disposition survey. If multiple action levels are identified, the planning team may decide to continue with the development of multiple survey designs that will be evaluated in Section 4.4.4. The decision maker and the planning team will need to evaluate the action levels and select the action level that best meets the DQOs developed for the survey. The selected action levels are used to develop decision rules in Section 3.7. Alternatively, the planning team may decide to revisit the selection of disposition options from the IA to further limit the scope of the disposition survey and eliminate some of the action levels. In either case, the selection of action levels will be finalized in Section 4.4 with the development of a disposition survey design. Information supporting the selection of an action level(s) is discussed in Sections 3.3.1 through 3.3.4.

[1] Converting action levels to counts or counts per minute (cpm) may provide a useful comparison for real-time evaluation of field measurement results as long as field results (e.g., cpm) are converted to and recorded in the same radiological units as the action levels.

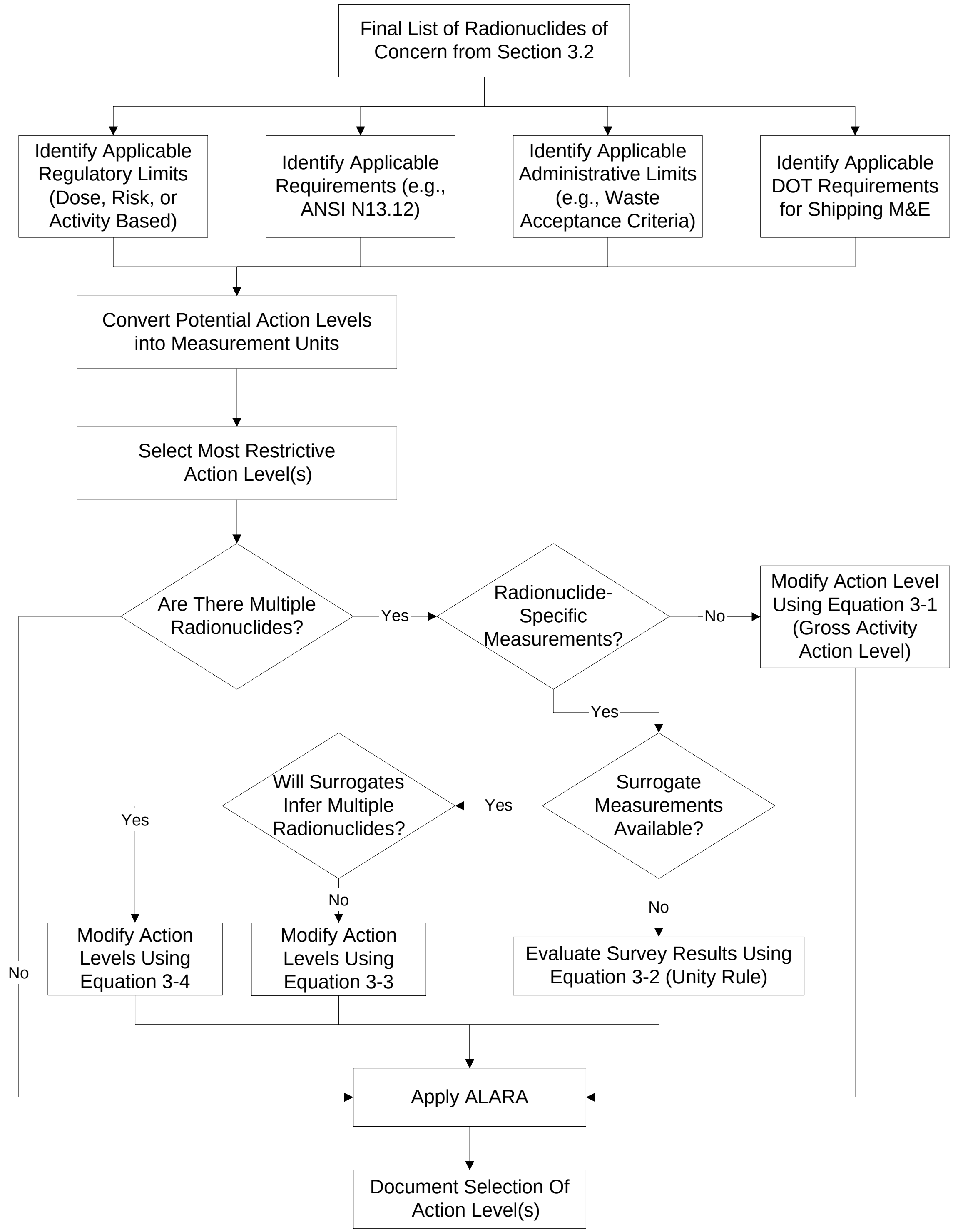

Figure 3.1 Identifying Action Levels (Apply to each Disposition Option Selected in Section 2.5)

3.3.1 Identify Sources of Action Levels

There are many potential sources of action levels available for use in developing disposition surveys. An action level may be based on:

- Dose- or risk-based regulatory standard (i.e., disposition criterion),
- Waste acceptance criteria at a disposal site,
- Regulatory threshold standard (e.g., indistinguishable from background or no detectable radioactivity),
- DOT regulations for shipping radioactive M&E,
- Activity-based standard,
- As low as reasonably achievable (ALARA) considerations,
- Administrative limits, or
- Limitations on technology (performance criteria for an analytical method).

Appendix E provides information on some of the sources of action levels that can be applied to M&E. The list of sources for action levels is not exhaustive, but is intended to provide examples of different types of action levels that are referred to throughout this supplement.

As previously stated, in many cases the action levels will be dictated by the disposition option selected during the IA. For example, the action levels for M&E being considered for clearance may be a regulatory standard, whereas the action levels for M&E being considered for disposal as radioactive waste will often use the waste acceptance criteria for a disposal site.

Multiple sources of action levels may be identified for a single disposition option. Waste acceptance criteria can be evaluated from several potential burial sites.

In addition, a single source of action levels could be acceptable for more than one disposition option. Dose- and risk-based regulatory standards can be applied to both release and recycle scenarios, as well as for surficial or volumetric radioactivity. On the other hand, activity-based standards may have limited applicability, such as DOE Order 5400.5 (DOE 1993) that only applies to release of M&E with surficial radioactivity.

The identification of sources for action levels may affect other decisions made during development of a disposition survey design. Identification of survey units and spatial boundaries for a survey are often directly linked to the action levels. In addition, the expected levels of residual radioactivity identified during the IA (see Section 2.6) will often suggest which disposition options are feasible.

At a minimum the planning team should identify at least one source of action levels applicable to the disposition option(s) selected during the IA. Any information related to the action levels that may affect other decisions should also be listed. A partial list of information that may be available from sources of action levels includes:

- Radionuclides of concern or types of radiation
- Assumptions regarding surficial or volumetric residual radioactivity
- Area or volume over which the residual radioactivity can be averaged
- Assumptions about potential disposition of the M&E (e.g., exposure scenarios, reuse vs. recycle)
- Conversions from dose or risk to activity or concentration (e.g., modeling and modeling assumptions)

3.3.2 Select the Most Restrictive Action Levels

In cases where more than one source of action levels is identified, it is necessary to select an action level to be the basis for the disposition survey design. Generally, the source that provides the most restrictive action levels (i.e., the most protective of human health and the environment) will be appropriate for designing the disposition survey. If the planning team cannot determine which action levels are most restrictive, multiple survey design should be developed and the selection of action levels will be determined by the selection of the most effective survey design (Section 4.4).

The expected location of residual radioactivity is an important factor in the selection of appropriate action levels. Some sources of action levels are only applicable for surficial radioactivity (e.g., DOE 1993, DOT regulation 49 CFR 173.433). Other sources of action levels (e.g., ANSI 1999) or dose assessments for deriving action levels (e.g., NRC 2003a) make assumptions about whether the residual radioactivity is surficial or volumetric, or a combination of both. Section 2.4.2.4 discusses the location of radioactivity associated with the M&E.

While the location of residual radioactivity is important in determining the most restrictive action levels, other physical and radiological characteristics should also be considered. The final selection of action levels should be supported by the description of the M&E provided by the IA (Section 2.6).

3.3.3 Modify Action Levels When Multiple Radionuclides are Present

The implementation of action levels should be considered when evaluating whether they will be applied to a specific survey unit or project. Section 3.3.1 discusses potential sources for action levels, and Section 3.2 discusses the approach for selecting the radionuclides of concern. Calculating the relative ratios among multiple radionuclides and determining the state of equilibrium for decay series radionuclides is discussed in MARSSIM Section 4.3. This section describes how individual action levels can be combined and applied when more than one radionuclide is present.

Action levels are often provided for types of radioactivity or groups of radionuclides. For example, DOE Order 5400.5 Figure IV-1 (DOE 1993) provides surface activity action levels for four groups of radionuclides (see Appendix E). For the simple case in which the activity is entirely attributable to one radionuclide, the action levels for that radionuclide are used for comparison to survey data. In these examples, the disposition survey data may be obtained from direct measurements of activity, scanning with data logging, conveyorized survey monitor surveys, or other appropriate methods.

Dose or risk-based action levels may be radionuclide-specific. Each radionuclide-specific action level corresponds to the chosen disposition criterion (e.g., regulatory limit in terms of dose or risk). For example, ANSI 1999 provides surface and volumetric activity action levels for individual radionuclides. When multiple radionuclides are present at concentrations equal to the action levels, the total dose or risk for all radionuclides would exceed the disposition criterion. In these cases it is possible to modify the action levels based on relationships between the radionuclides of concern and still demonstrate compliance with the disposition criterion.

The method used to modify the action levels depends on the radionuclides of concern and the selected measurement method. If the measurement method reports total activity for a type of radiation (e.g., gross α, β, or γ assays) the method is non-radionuclide specific and the guidance in Section 3.3.3.1 should be applied. If the measurement reports activity for individual radionuclides (e.g., gamma spectrometry, alpha spectrometry) the method is radionuclide specific and the guidance in Section 3.3.3.3 should be applied.

3.3.3.1 Modify Action Levels for Non-Radionuclide Specific Measurement Methods

For situations in which there are radionuclide-specific action levels and multiple radionuclides are present, a gross activity action level can be developed. Gross activity action levels are also discussed in Section 4.3.4 of MARSSIM. This approach enables field measurement of gross activity (using static direct measurements or scans), rather than determination of individual radionuclide activity, for comparison to the action levels. The gross activity action level for M&E with multiple radionuclides is calculated as follows:

1. Determine the relative fraction (f) of the total activity contributed by the radionuclide.[2]
2. Obtain the action level for each radionuclide present.
3. Substitute the values of f and action levels in the following equation.

$$\text{Gross Activity AL} = \frac{1}{\left(\frac{f_1}{\text{AL}_1} + \frac{f_2}{\text{AL}_2} + \ldots \frac{f_n}{\text{AL}_n}\right)} \qquad \textbf{(3-1)}$$

Where:

f_i = relative fraction of total activity contributed by radionuclide i (i = 1, 2,…, n)
AL_i = action level for radionuclide i

For example, assume that 40 percent of the total radioactivity was contributed by a radionuclide with an action level of 1.4 Bq/cm^2 (8,400 dpm/100 cm^2). An additional 40 percent of the total radioactivity was contributed by a radionuclide with an action level of 0.28 Bq/cm^2 (1,700

[2] The determination of relative fractions may be based on process knowledge, empirical data, or a combination of both. It may be difficult or impractical to determine the relative fractions contributed by all radionuclides of concern. The alternatives are to analyze each radionuclide independently, or use conservative assumptions to determine the relative fractions. Additional guidance is provided in MARSSIM Section 4.3.

dpm/100 cm^2), and the final 20 percent of the radioactivity was contributed by a radionuclide with an action level of 0.14 Bq/cm^2 (840 dpm/100 cm^2). Using Equation 3-1:

$$\text{Gross Activity AL} = \frac{1}{\left(\frac{0.40}{1.4} + \frac{0.40}{0.28} + \frac{0.20}{0.14}\right)} = 0.32\ \text{Bq/cm}^2\ (1{,}900\ \text{dpm/100 cm}^2)$$

Equation 3-1 may not be appropriate for survey units with radioactivity from multiple radionuclides having unknown or highly variable concentrations of radionuclides. In these situations, the best approach may be to select the most restrictive surface activity action level from the mixture of radionuclides present.[3] If the mixture contains radionuclides that cannot be measured using field survey equipment, such as ^{3}H or ^{55}Fe, laboratory analyses of M&E samples may be necessary.

3.3.3.2 Modify Action Levels for Non-Radionuclide Specific Measurements of Decay-Series Radionuclides

Demonstrating compliance with surface activity action levels for radionuclides of a decay series (e.g., radium, thorium, and uranium) that emit both alpha and beta radiation may be demonstrated by assessing alpha, beta, or both radiations. However, relying on the use of alpha surface activity measurements often proves problematic because of the highly variable level of alpha attenuation by rough, porous, uneven, and dusty surfaces. Beta measurements typically provide a more accurate assessment of thorium and uranium (and their progeny) on most building surfaces because surface conditions cause significantly less attenuation of beta particles than alpha particles. Beta measurements, therefore, may provide a more accurate determination of surface activity than alpha measurements.

The relationship of beta and alpha emissions from decay chains or various enrichments of uranium should be considered when determining the surface activity for comparison with the action level values. When the initial member of a decay series has a long half-life, the radioactivity associated with the subsequent members of the series will increase at a rate

[3] For the example provided, the most conservative action level is 0.14 Bq/cm^2.

determined by the individual half-lives until all members of the decay chain are present at activity levels equal to the activity of the parent. This condition is known as secular equilibrium. Pages 4-6 and 4-7 in MARSSIM also provide a discussion on secular equilibrium.

The difficulty with radionuclides that are part of a natural decay series is that time must pass for a sufficient number of half-lives of the longest-lived progeny that intervenes between a radionuclide and its parent in order to establish secular equilibrium. In the case of ^{232}Th, the time to establish secular equilibrium is almost 40 years. This is because ^{232}Th decays into ^{228}Ra, which has a half-life of 5.75 years. In the case of ^{238}U, the time to establish secular equilibrium is approximately 2 million years. This is because ^{234}U has a half-life of approximately 250,000 years. ^{226}Ra, another member of the ^{238}U decay series, presents special problems. ^{226}Ra decays into ^{222}Rn, which is a noble gas that can escape the matrix and disrupt equilibrium. It is important to remember the reason for determining relationships between radionuclides. If the relationships are known or can be estimated,[4] the costs and amount of time required for performing measurements can be significantly reduced. The alternative to determining the relationships between radionuclides is performing radionuclide-specific measurements for each radionuclide of concern.

Consider an example in which the radionuclide of concern is ^{232}Th, and all of the progeny are in secular equilibrium. Assume that a gas proportional detector will be used for surface activity measurements. The detector's efficiency is dependent upon the radionuclide mixture measured and the calibration source area. Guidance from the International Organization for Standardization (ISO 1988) states:

> "The dimensions of the calibration source should be sufficient to cover the window of the instrument detector. Where, in extreme cases, sources of such dimensions are not available, sequential measurements with smaller distributed sources of at least 100 cm^2 active area shall be carried out. These measurements shall cover the whole window area or at least representative fractions of it and shall result in an average value for the instrument efficiency."

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[4] There are risks and tradeoffs associated with using estimated values. The planning team should compare the consequences of potential decision errors with the resources required to improve the quality of existing data to determine the appropriate approach for a specific project.

The concentration of ^{232}Th is inferred from a measurement that includes the parent and all of its progeny. The efficiency of such measurements, relative to each decay of ^{232}Th, can be greater than 100 percent. The efficiency, relative to each decay of ^{232}Th, is calculated by weighting the individual efficiencies from each of the radionuclides present (see Table 3.1).

Table 3.1 Example Detector Efficiency Calculation (^{232}Th in complete equilibrium with its progeny) Using a Gas Proportional Detector

Radionuclide	Energy* (keV)	Fraction	Instrument Efficiency	Surface Efficiency	Weighted Efficiency
^{232}Th	4.00 MeV alpha	1	0.40	0.25	0.1
^{228}Ra	7.2 keV beta	1	0	0	0
^{228}Ac	377 keV beta	1	0.54	0.50	0.27
^{228}Th	5.40 MeV alpha	1	0.40	0.25	0.1
^{224}Ra	5.67 MeV alpha	1	0.40	0.25	0.1
^{220}Rn	6.29 MeV alpha	1	0.40	0.25	0.1
^{216}Po	6.78 MeV alpha	1	0.40	0.25	0.1
^{212}Pb	102 keV beta	1	0.40	0.25	0.1
^{212}Bi	769 keV beta	0.64	0.66	0.50	0.211
^{212}Bi	6.05 MeV alpha	0.36	0.40	0.25	0.036
^{212}Po	8.78 MeV alpha	0.64	0.40	0.25	0.064
^{208}Tl	557 keV beta	0.36	0.58	0.50	0.104
				Total efficiency = 1.29	

* Alpha energies are weighted averages based on relative abundance of major particle emissions totaling at least 90% of the total emissions. Beta energies are average energies. Source: Japanese Atomic Energy Research Institute data from NRC Radiological Toolbox Version 1.0.0 (NRC 2003b).

It is important to recognize that if the action level for ^{232}Th includes the entire ^{232}Th decay series, the total efficiency for ^{232}Th must account for all of the radiations in the decay series. The total weighted efficiency calculated in Table 3.1 may be used to modify action levels for non-radionuclide specific measurements using a gas proportional counter to measure thorium series radionuclides. The total weighted efficiency can be substituted into an equation (e.g., MARSSIM equations 6-1, 6-2, 6-3, or 6-4) to convert the action level (e.g., activity units) into measurement units (e.g., counts or cpm). The modified action level can then be compared directly to the measurement results for a real time assessment of the data.

3.3.3.3 Modify Action Levels for Radionuclide Specific Measurement Methods

In many cases action levels correspond to a disposition criterion (e.g., a regulatory limit) in terms of dose or risk. When multiple radionuclides are present at concentrations equal to the action levels, the total dose or risk for all radionuclides would exceed a risk or dose-based disposition criterion. In this case, the individual action levels would need to be adjusted to account for the presence of multiple radionuclides contributing to the total dose or risk. The surrogate measurements discussed in this section describe adjusting action levels to account for multiple radionuclides when radionuclide-specific analyses of media samples or radionuclide–specific in situ measurements (e.g., in toto measurements, in situ gamma spectroscopy) are performed. The use of surrogate measurements is also described in Section 4.3.2 of MARSSIM. Other methods used to account for the presence of multiple radionuclides include the use of the unity rule (MARSSIM Section 4.3.3) and development of a gross activity action level to adjust the individual radionuclide action levels (see Section 3.3.3.1 and MARSSIM Section 4.3.4).

The unity rule is satisfied when radionuclide mixtures yield a combined fractional concentration limit that is less than or equal to one. The unity rule can be described by Equation 3-2:

$$\frac{\mathrm{C}_1}{\mathrm{AL}_1}+\frac{\mathrm{C}_2}{\mathrm{AL}_2}+...+\frac{\mathrm{C}_n}{\mathrm{AL}_n}\leq 1 \qquad \textbf{(3-2)}$$

Where:

C_i = concentration or activity value for each individual radionuclide (i = 1, 2, …, n)[5]
AL_i = action level value for each individual radionuclide (i = 1, 2, …, n)

For the disposition of M&E that contain multiple radionuclides, it may be possible to measure just one of the radionuclides and still demonstrate compliance for all of the radionuclides present in the M&E through the use of surrogate measurements. In the use of surrogates, it is often

[5] C (radionuclide concentration) must be in the same units as the action level. If the action level is provided in activity units, C will also be in units of activity.

difficult to establish a "consistent" ratio between two or more radionuclides. Rather than follow prescriptive guidance on acceptable levels of variability for the surrogate ratio, the planning team should review the data collected to establish the ratio (e.g., from preliminary surveys or process knowledge) and account for the variability as a measurement quality objective (MQO) during selection of a measurement method (see Section 3.8 and Chapter 5). The action levels must then be modified to account for the fact that one radionuclide is being used to account for the presence of one or more other radionuclides.

Action levels for the measured radionuclide are modified ($AL_{meas,mod}$) to account for a single inferred radionuclide (e.g., inferring ^{55}Fe based on the presence of ^{60}Co) using Equation 3-3 (modified from Equation 6.2 in Abelquist 2001):

$$AL_{meas,mod} = (AL_{meas})\left(\frac{AL_{infer}}{\left(\frac{C_{infer}}{C_{meas}}\right)AL_{meas} + AL_{infer}}\right) \quad \textbf{(3-3)}$$

Where:

$AL_{meas,mod}$ = modified action level for the radionuclide being measured
AL_{meas} = action level for the radionuclide being measured
AL_{infer} = action level for the inferred radionuclide (i.e., not measured)
C_{infer}/C_{meas} = surrogate ratio of the inferred to the measured radionuclide.

When the measured radionuclide will be used as a surrogate for more than one radionuclide, $AL_{meas,mod}$ can be calculated using Equation 3-4 (MARSSIM Equation I-14):

$$AL_{meas,mod} = \frac{1}{\left(\frac{1}{AL_1} + \frac{R_2}{AL_2} + \frac{R_3}{AL_3} + \ldots + \frac{R_n}{AL_n}\right)} \quad \textbf{(3-4)}$$

Where:

AL_1 = the action level for the measured radionuclide by itself
AL_2 = the action level for the second radionuclide (or first radionuclide being inferred) that is being inferred by the measured radionuclide
R_2 = the ratio of concentration of the second radionuclide to that of the measured radionuclide

AL_3 = the action level for the third radionuclide (or second radionuclide being inferred) that is being inferred by the measured radionuclide

R_3 = the ratio of concentration of the third radionuclide to that of the measured radionuclide

AL_n = the action level for subsequent radionuclides being inferred by the measured radionuclide

R_n = the ratio of concentration of subsequent radionuclides to that of the measured radionuclide.

Recall that the benefit of using surrogates is the avoidance of costly laboratory-based analytical methods to provide estimates of activity for individual radionuclides of concern. Surrogates often emit γ-rays, which enable the use of noninvasive and nondestructive methods. However, α- and β-emitting radionuclides can also be used as surrogates, depending on the objectives of the survey and project-specific information. The surrogates come in two forms: (1) surrogates by virtue of a decay series, and (2) surrogates by virtue of association. Surrogates that are part of a decay series are discussed in Section 3.3.3.2. Radionuclides that are not part of a decay series have the potential to be surrogates when they are produced by the same nuclear process (usually fission or activation) and have similar chemical properties and release mechanisms. However, this type of surrogate needs special attention because there must be a consistent ratio between the measured radionuclide and surrogate, which is not always easy to demonstrate. For example, in the case of nuclear power reactors, ^{60}Co can be used as a surrogate of ^{55}Fe and ^{63}Ni because both are activation-corrosion products with similar chemical properties. Similarly, ^{137}Cs can be used as a surrogate for the β-emitting ^{90}Sr because both are fission products and are generally found in soluble cationic forms. While ^{137}Cs has been suggested as a possible surrogate for ^{99}Tc, it must be noted that ^{99}Tc has different chemical properties and, in nuclear power reactors, it has different release mechanisms. Additional information is available on surrogates and establishing ratios (MARSSIM 2002, NRC 2000, and EPRI 2003).

3.3.4 Evaluate Interface With Exposure Pathway Models

Disposition criteria may be provided in units that cannot be measured directly, for example total effective dose equivalent (TEDE) or lifetime risk of cancer incidence. These criteria are usually converted into action levels with concentration or activity units. This conversion is typically accomplished using exposure pathway models, such as RESRAD-Recycle for metals (DOE 2005). While the selection and application of these models is outside the scope of MARSAME, the assumptions used to develop action levels should be considered during development of a disposition survey design.

Alternatively, disposition criteria may be provided in units more easily measured. In general, there are assumptions used in the development of these types of action levels. It is the responsibility of the authority issuing the action levels to ensure regulatory involvement in their development and to document and make assumptions available to users.

The assumptions used to design the disposition survey (Section 4.4) need to match the assumptions used to develop the action levels. Examples of parameters that could affect disposition survey designs include:

- Volume, mass, or surface area of M&E
- Accessibility
- Physical and chemical characteristics of radionuclides or radiations of concern (types of emissions, energies, half-lives, known or expected relationships)
- Distribution of radioactivity (uniform or variable)
- Location of radioactivity (surficial or volumetric)
- Fixed, removable, or some combination, radioactivity (resuspension)

3.4 Describe the Parameter of Interest

The parameter of interest is the population parameter (e.g., mean, median, percentile, or total amount) that the planning team considers to be important for making decisions about the target population (EPA 2006a). The target population is the collection of all possible measurement results that could be used to support a disposition decision concerning the M&E being investigated. The target population is defined by the selection of survey unit boundaries (see Section 3.6), since a separate disposition decision will be made for each survey unit.

The parameter of interest may be specified as part of the action level. For example, DOE Order 5400.5 Figure IV-1 (DOE 1993) lists action levels (i.e., surface concentration limits in dpm per 100 cm^2), parameters of interest (i.e., mean and maximum values), and target populations (i.e., 1 m^2 for average concentration and 100 cm^2 for maximum and removable limits).

Alternatively, the planning team may need to select the parameter of interest based on project-specific needs and considerations. The most common parameter used in decision-making is the mean because the mean is frequently used to model random exposure to environmental contamination (EPA 2006a). The more complex the parameter of interest, the more complex will be the decision rule (see Section 3.7) and accompanying survey design. A statistician should be consulted if the planning team is unsure of which parameter of interest to select.

3.5 Identify Alternative Actions

Before decision rules can be developed, the planning team needs to identify the alternative actions based on the disposition options identified in Section 2.5. Alternative actions are the possible actions that may be taken for disposition of M&E, including an alternative that requires no action. Table 3.2 lists examples of alternative actions for disposition options listed in Section 2.5.

3.6 Identify Survey Units

To make a decision concerning the disposition of M&E it is necessary to describe the total collection of M&E being investigated and define what segment of the total will be considered for individual decisions. In other words, the planning team must specify the amount of M&E for which a separate disposition decision will be made. When the M&E consist of discrete items surveyed individually (e.g., hand tools) this task is simple. However, disposition decisions are often required for more complex situations (e.g., bulk dispersible materials, excavation equipment). Survey unit boundaries should be clearly defined in order to know exactly what amount of M&E is covered by a single decision. This clear and unambiguous definition will make data interpretation more straightforward.

An M&E survey unit is the specific lot, amount, or piece of equipment on which measurements are made to support a disposition decision concerning that specific lot, amount, or piece of equipment. The purpose of this section is to identify the information that will be used to define the survey unit boundaries. The expected output from this section is the identification of survey unit boundaries that will be used to develop the decision rule in Section 3.7. Figure 3.2 shows the process used to develop survey unit boundaries.

Table 3.2 Example Alternative Actions

Disposition Option	Alternative Actions
Release for reuse	Reuse without radiological controls
	Reuse with radiological controls
	Maintain current level of radiological control and do not reuse (no action)
Release for recycle	Recycle without radiological controls
	Recycle with radiological controls
	Maintain current level of radiological control and do not recycle (no action)
Release for disposal	Dispose of M&E as municipal or industrial waste
	Dispose of M&E as low-level radioactive waste
	Dispose of M&E as high-level radioactive waste
	Dispose of M&E as transuranic (TRU) waste
	Maintain current level of radiological control without disposal (no action)
Interdiction	Remove M&E from general commerce and initiate radiological controls
	Decision not to use or accept M&E for a specific application
	Continued unrestricted use of M&E (no action)

Survey unit boundaries are affected by many variables associated with the action level, physical properties of the M&E, characteristics of the radionuclides of concern, and available measurement techniques. Variables affecting the definition of survey units include:

- Action Level (Section 3.3)
    - Assumptions used to develop the action level (e.g., surficial or volumetric, Section 3.3.1)
    - Modeling assumptions used to convert from dose or risk to concentration or activity (Section 3.3.4)

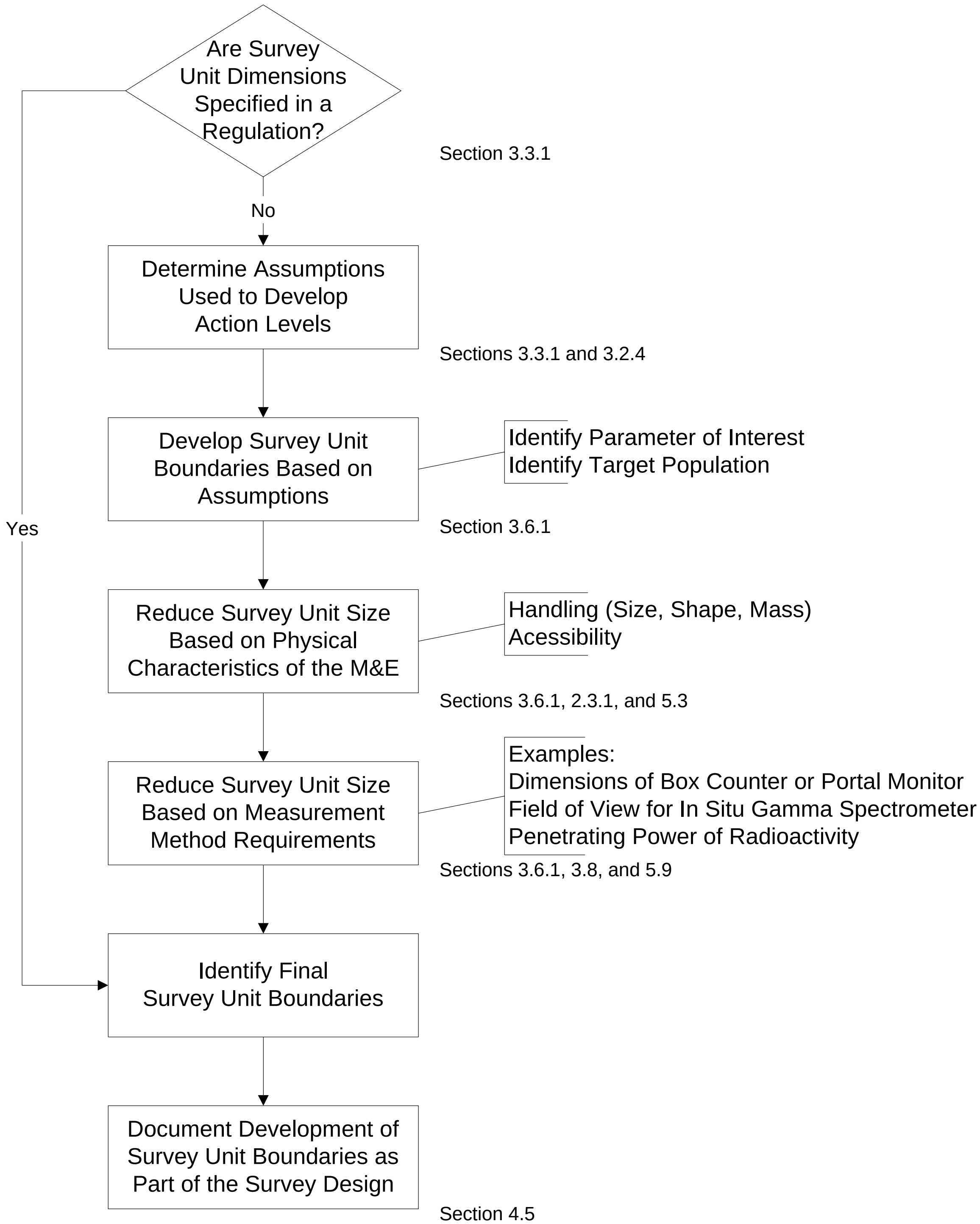

Figure 3.2 Developing Survey Unit Boundaries (Apply to all Impacted M&E for each set of Action Levels Identified in Section 3.3)

- Physical Properties of the M&E (Section 2.4.1)
  - o Dimensions (i.e., size, shape, surface area)
  - o Complexity (i.e., number and type of components)
  - o Accessibility (i.e., measurability)
  - o Inherent value
- Radiological Attributes of the M&E (Section 2.4.2)
  - o Radionuclides of concern (e.g., major radiations and energies, half-life)
  - o Expected activity levels (e.g., average, range, variance, known or potential relationships)
  - o Distribution (i.e., uniform or non-uniform)
  - o Location (i.e., surficial or volumetric)
- Available Measurement Methods (Section 3.8, Section 5.9)
  - o Measurement quality objectives (MQOs, Section 3.8)
  - o Measurement performance characteristics (Section 5.5)

3.6.1 Define Initial Survey Unit Boundaries

Initial survey unit boundaries should be developed based on one primary factor and modified, as needed, using additional variables. MARSAME recommends using the assumptions used to develop the action levels as the primary factor used to develop survey unit boundaries. The modifying variables will usually be specific to a measurement technique, or determined by the M&E being investigated.[6]

In many cases the action levels will define the survey unit boundaries. For example, DOE Order 5400.5 Figure IV-1 (DOE 1993) provides action levels for surface activity. The survey unit boundaries are restricted to the surface of the M&E being investigated. Alternatively, NUREG-

[6] This approach differs from guidance found in MARSSIM Section 4.6. While MARSSIM also uses the assumptions used to develop the action levels (i.e., DCGLs) as the primary factor in developing survey unit boundaries, the modifications are different. MARSSIM guidance allows increasing and decreasing survey unit size based on classification. In MARSSIM, Class 1 survey units are generally smaller than the area assumed in the exposure pathway model, while MARSSIM allows Class 3 survey units to be larger in area. Additional modifications to survey unit boundaries in MARSSIM can be made based on site-specific variables (e.g., room size, topography).

1640 (NRC 2003a) provides modeling assumptions used to develop the action levels for different materials. Radionuclide-specific action levels are provided for separate materials (e.g., ferrous metals, concrete) for both surficial and volumetric radioactivity. In addition, each action level lists the limiting exposure scenario. For example, exposure scenarios for concrete (NRC 2003a) include:

- Worker processing concrete rubble at a satellite facility,
- Truck driver hauling concrete rubble,
- Worker building a road using recycled concrete,
- Driver on a road built using recycled concrete,
- Worker handling concrete rubble at an industrial landfill,
- Worker handling concrete rubble at a municipal landfill,
- Individual drinking groundwater contaminated with leachate from an industrial landfill, and,
- Individual drinking groundwater contaminated with leachate from a municipal landfill.

Each exposure scenario assumes different conditions that help define survey unit boundaries. For example, a truck driver hauling concrete rubble would be exposed to one truckload of concrete rubble, so the survey unit boundaries would be defined by a truckload of concrete rubble (i.e., 2×10^4 kg [22 tons] or 8.3 cubic meters, NRC 2003a).

3.6.2 Modify Initial Survey Unit Boundaries

Modifications to survey unit boundaries are expected based on practical constraints for data collection activities. In most cases smaller survey units will be acceptable, since a reduction in size would not result in an increased dose or risk. Increasing the size of the survey unit may result in increased dose or risk, and therefore requires approval of the planning team and stakeholders.

Constraints on collecting data are often associated with specific measurement techniques, which could affect the survey unit boundaries. For example, using in situ gamma spectrometry may restrict survey unit sizes based on the field of view of the detector, the penetrating power of the gamma energies being measured, or the assumptions used to develop the instrument efficiency. Alternatively, using a box counter or portal monitor may restrict survey unit sizes based on what will fit inside or through the detector. Information on measurement parameters affecting disposition survey design is provided in Section 3.8. Chapter 5 and Appendix D provide detailed information on specific measurement methods.

The M&E being investigated may also cause modifications to survey unit boundaries. These modifications are often associated with physical characteristics (e.g., size, shape). Identification of actual survey units as part of the final disposition survey design is discussed in Chapter 4.

3.7 Develop a Decision Rule

In order to design a disposition survey, the user should define a decision rule describing the conditions for selecting between alternative actions. The planning team should assume that ideal data are available and there is no uncertainty in the decision making process. The available data are integrated into an "if...then..." statement, which is the theoretical decision rule.[7]

The decision rule is constructed by combining the action level (Section 3.3) and the parameter of interest (Section 3.4) with the alternative actions (Section 3.5) in an "if...then..." statement.

For example:

> Hypothetically, if the mean concentration of ^{226}Ra in 20,000 kg (8.3 cubic meters, one truckload) of concrete rubble is less than the clearance action level of 0.34 Bq/g for volumetric radioactivity, then the concrete rubble can be cleared, otherwise radiological control of the concrete will continue.

It may be necessary to develop more than one decision rule. For example, if more than one action level is selected in Section 3.3, a separate decision rule needs to be developed for each action level. In addition, selection of multiple disposition options in Section 2.5 (e.g., release

[7] This is called a theoretical decision rule because it is stated in terms of the true value for the parameter of interest, even though in reality this value cannot be known. An operational decision rule that is based on an estimate of the target population parameter of interest will be incorporated as part of the final disposition survey design selected and documented in Chapter 4.

and disposal as low-level radioactive waste) may result in multiple alternative actions requiring multiple decisions and multiple decision rules. For example:

> Hypothetically, if the mean concentration of ^{226}Ra in 20,000 kg (8.3 cubic meters, one truckload) of concrete rubble is less than the clearance action level of 0.34 Bq/g for volumetric radioactivity, then the concrete rubble can be cleared, otherwise the concrete will be considered for disposal as low-level radioactive waste. If the concrete rubble meets the waste acceptance criteria for the low-level radioactive waste disposal facility (e.g., mean and total activity levels, chemical and physical form, toxicity) the concrete will be packaged and transported for disposal, otherwise radiological control of the concrete will continue.

3.8 Develop Inputs for Selection of Provisional Measurement Methods

The identification and evaluation of provisional measurement methods is an important step in developing a disposition survey design. A measurement method is the combination of instrumentation (e.g., GM detector, NaI(Tl) scintillation detector, gamma spectrometer) with a measurement technique (i.e., scan, in situ, sample collection). The selection of a measurement method is discussed in more detail in Section 5.9. The availability of measurement methods and the amount of resources required to implement specific measurement methods is an important factor in selecting between different survey designs, or in reducing the number of options to be considered when developing potential disposition survey designs.

There are two potential results of this evaluation of provisional measurement methods. First, the evaluation may identify specific measurement methods that will be included in the final documentation of the selected disposition survey design (see Section 4.5). For example, scanning 100% of a piece of equipment using a 2-inch by 2-inch NaI(Tl) detector at a specified height above the surface using a specified scan speed may be identified as the measurement method. Second, the evaluation may identify characteristics of a measurement method required to meet the objectives of a survey. These characteristics are called measurement quality objectives (MQOs).

Examples of MQOs are described in the following sections. A list of minimum MQOs required for a survey can be developed and documented in the final disposition survey design (see Section 4.5). The selection of a measurement technique that meets the MQOs is accomplished during implementation of the survey design.

This section focuses on measurability. Most of the variables that need to be considered for the identification of measurement techniques have been discussed earlier in this chapter. The identification of measurement methods is directly or indirectly related to:

- Identification of radionuclides of concern,
- Location of residual radioactivity,
- Application of action levels,
- Physical properties of the M&E,
- Uniformity of residual radioactivity,
- Expected levels of residual radioactivity,
- Relationships between radionuclide activities,
- Equilibrium status of natural decay series, and
- Background radioactivity.

Measurable radioactivity is radioactivity that can be quantified and meets the DQOs and MQOs established for the survey. Radioactivity that is quantified using known or predicted relationships developed from process knowledge or preliminary measurements is considered measurable as long as the relationships are developed and verified as specified in the DQOs and MQOs. The Multi-Agency Radiological Laboratory Analytical Protocols Manual (MARLAP)[8] lists method performance characteristics that should be considered when establishing MQOs for a project. This list is not intended to be exhaustive.

- The method uncertainty at a specified concentration (expressed as a standard deviation),
- The method's detection capability (expressed as the minimum detectable concentration, or MDC),

[8] MARLAP was developed for selecting laboratory protocols. Applying the framework and performance-based approach for planning and conducting radiological work from MARLAP to the selection of field measurement techniques is an expansion of the original scope and purpose of MARLAP.

- The method's quantification capability (expressed as the minimum quantifiable concentration, or MQC),
- The method's range, which defines the method's ability to measure the radionuclide of concern over some specified range of concentration,
- The method's specificity, which refers to the ability of the method to measure the radionuclide of concern in the presence of interferences, and
- The method's ruggedness, which refers to the relative stability of method performance for small variations in method parameter values.

Project-specific method performance characteristics should be developed as necessary and may or may not include the characteristics listed here. Once lists of performance characteristics that affect measurability have been identified, the planning team should develop MQOs describing the project-specific objectives for potential measurement techniques. Potential measurement techniques should be evaluated against the MQOs to determine if they are capable of meeting the objectives for measurability.

3.8.1 Measurement Method Uncertainty

The required measurement method uncertainty is perhaps the most important MQO to be established during the planning process. Chapter 4 discusses the rationale involved in setting the required measurement method uncertainty. Chapter 5 discusses procedures for determining the required method uncertainty and whether or not it has been achieved. MARLAP uses the term method uncertainty to refer to the predicted uncertainty of a measured value that would likely result from the performance of a measurement at a specified concentration, typically the action level. Reasonable values for method uncertainty can be predicted for a particular measurement technique based on typical values for specific parameters (e.g., count time, efficiency) and process knowledge for the M&E being investigated (see Section 5.5). The MQO for measurement method uncertainty is related to the width of the gray region (see Section 4.2.2). The required measurement method uncertainty is directly related to the MDC and the minimum quantifiable concentration (MQC) discussed below.

The distinction between imprecision and bias as a data quality indicator depends on context. Additional information on data quality indicators can be found in MARSSIM Appendix N and

EPA QA/G-5 (EPA 2002a). A reliable estimate of bias requires a data set that includes many measurements, so MARSAME and MARLAP focus on developing an MQO for measurement method uncertainty. Measurement method uncertainty effectively combines imprecision and bias into a single parameter whose interpretation does not depend on context. This approach assumes that all potential sources of bias present in the measurement process have been considered in the estimation of the measurement uncertainty and, if not, that any appreciable bias would only be detected after a number of measurements of quality control (QC) and performance evaluation samples have been performed (see QC discussion in Section 5.10). MARLAP Appendix C provides examples on developing MQOs for measurement method uncertainty of laboratory measurement techniques.

3.8.2 Detection Capability

The MDC (see Section 5.6) is recommended as the MQO for defining the detection capability, and is an appropriate MQO when decisions are to be made based on a single measurement as to whether excess radioactivity is present or not. The MDC must not exceed the action level if the MDC is to be used as a decision parameter. Chapter 5 provides guidance on implementation of the selected measurement technique, including calculation of the MDC. Additional information on calculating the MDC can be found in MARSSIM (Section 6.7, examples in Appendix H) and MARLAP (Chapter 19, Appendix C).

3.8.3 Quantification Capability

When the average of several measurements will be compared to a disposition criterion, an MQO more stringent than the MDC is required. The MQC (see Section 5.7) is recommended as the parameter for defining the measurement capability for making quantitative comparisons of averages to a limit. An MQO for the required measurement method uncertainty (see Section 5.6) is related to an MQO for the quantification capability since an MQC is defined as the concentration at which a specified relative standard uncertainty is achieved. MARLAP presents three reasons why it is important to consider this measurement method performance characteristic:

1. To emphasize the importance of the quantification capability of a measurement technique for instances when the issue is not whether a radionuclide is present or not (e.g., measuring ^{238}U in soil where the activity is inherent) but rather how precisely the radionuclide can be measured,
2. To promote the MQC as an important measurement method performance characteristic for comparison of measurement techniques, and
3. To provide an alternative to the overemphasis on establishing required MDCs in instances where detection (i.e., reliably distinguishing a radionuclide concentration from zero) is not the key analytical issue.

The MQC must not exceed the action level if the MQC is to be used as a decision parameter. Chapter 5 provides guidance on implementation of the selected measurement technique, including calculation of the MQC. Section 5.8 describes the theoretical basis of the MQC calculation. Additional information on calculating the MQC can be found in MARLAP Chapter 19, with examples in MARLAP Appendix C.

3.8.4 Range

The expected concentration range for a radionuclide of concern (see Section 2.4.2) may be an important measurement method performance characteristic. Most radiation measurement techniques are capable of measuring over a wide range of radionuclide concentrations. However, if the expected concentration range is large, the range should be identified as an important measurement method performance characteristic and an MQO should be developed. The MQO for the acceptable range should be a conservative estimate. This will help prevent the selection of measurement techniques that cannot accommodate the actual concentration range.

3.8.5 Specificity

Specificity is the ability of the measurement method to measure the radionuclide concern in the presence of interferences. To determine if specificity is an important measurement method performance characteristic, the planning team will need information on expected concentration ranges for the radionuclides of concern and other chemical and radionuclide constituents, along with chemical and physical attributes of the M&E being investigated (see Section 2.4). The importance of specificity depends on:

- The chemical and physical characteristics of the M&E being investigated,
- The chemical and physical characteristics of the residual radioactivity, and
- The expected concentration range for the radionuclides of concern.

If potential interferences are identified (e.g., inherent radioactivity, similar radiations), an MQO should be established for specificity.

If inherent radioactivity is associated with the M&E being investigated, a method that measures total activity may not be acceptable. Consider concrete, which contains measurable levels of naturally occurring radioactivity and emits radiation in the form of alpha particles, beta particles, and photons. If the action level for the radionuclide of concern is close to background (e.g., within a factor of 3) gross measurement methods may not meet the survey objectives. Performing gross alpha measurements using a gas proportional detector may not provide an acceptable MDC or MQC for plutonium isotopes, where a more specific measurement method such as alpha spectrometry following radiochemical separation would be acceptable.

Radionuclides have similar radiations if they emit radiations of the same type (i.e., alpha, beta, photon) with similar energies. For example, both ^{226}Ra and ^{235}U emit a gamma ray with energy of approximately 186 keV. Gamma spectrometry may not be able to resolve mixtures of these two radionuclides, which are both associated with naturally occurring radioactivity. More specific methods involving ingrowth of ^{226}Ra daughters or chemical separation prior to measurement can be used to accurately quantify the radionuclides.

Documented measurement methods should include information on specificity. MARSSIM Table 7.2 lists examples of references providing laboratory measurement methods. NUREG-1506 (NRC 1995) provides generic information on field measurement techniques, but most field measurement methods are documented in proprietary SOPs. If specificity is identified as an important issue for a project, consultation with an expert in radiometrics or radiochemistry is recommended.

3.8.6 Ruggedness

For a project that involves field measurements that are performed in hostile, hazardous, or variable environments, or laboratory measurements that are complex in terms of chemical and physical characteristics, the measurement method's ruggedness may be an important method performance characteristic. Ruggedness refers to the relative stability of the measurement technique's performance when small variations in method parameter values are made. For field measurements the changes may include temperature, humidity, or atmospheric pressure. For laboratory measurements, a change in pH or the quantity of a reagent may be important. In order to determine if ruggedness is an important measurement method performance characteristic, the planning team needs detailed information on the chemical and physical characteristics of the M&E being investigated and operating parameters for the radiation instruments used by the measurement technique. Information on the chemical and physical characteristics of the M&E is available as outputs from the IA. Information on the operating parameters for specific instruments should be available from the instrument manufacturer. Generic information for radiation detector operating parameters may be found in consensus standards. A limited list of examples of consensus standards is provided in Table 3.3.

Table 3.3 Examples of Consensus Standards for Evaluating Ruggedness

Standard Number	Title
ANSI N42.12-1994	American National Standard Calibration and Usage of Thallium-Activated Sodium Iodide Detector Systems for Assay of Radionuclides
ANSI N42.17A-2003	American National Standard Performance Specifications for Health Physics Instrumentation – Portable Instrumentation for Use in Normal Environmental Conditions
ANSI N42.17C-1989	American National Standard Performance Specifications for Health Physics Instrumentation – Portable Instrumentation for Use in Extreme Environmental Conditions
ANSI N42.34-2003	American National Standard Performance Criteria for Hand-held Instruments for the Detection and Identification of Radionuclides.
IEEE 309-1999/ ANSI N42.3-1999	Institute of Electrical and Electronics Engineers, Inc. Standard Test Procedures and Bases for Geiger Mueller Counters
ASTM E1169-2002	Standard Guide for Conducting Ruggedness Tests

If it is determined that measurement method ruggedness is an important performance characteristic, an MQO should be developed. The MQO may require performance data that demonstrate the measurement technique's ruggedness for specified changes in select measurement method parameters. Alternatively, the MQO could list the acceptable ranges for select measurement method parameters and monitor the parameters as part of the QC program for the project (see Section 5.10). For example, sodium iodide detectors are required to perform within 15% of the calibrated response between zero and 40 degrees Celsius (32 and 104 degrees Fahrenheit, respectively) (ANSI 1994). The disposition survey design may call for a work stoppage at temperatures outside this range, or an increase in the frequency of QC measurements at temperatures outside this range.

3.9 Identify Reference Materials

Action levels may be developed that are related to background radioactivity, either based on an incremental dose or risk above background, as an administrative limit based on background, or as a limit on technology (e.g., minimum detectable concentration). For situations where the action levels are incremental above background, reference materials should be identified to provide an estimate of background. MARSSIM Section 4.5 provides guidance on determining when a reference material is required.

Reference materials are used to develop an estimate of the distribution of background radioactivity that can be compared to the measurements performed in a comparable survey unit. The reference material is selected to provide information on the level of radioactivity that would be present if the M&E being investigated had not been radiologically impacted.

The ideal reference data is obtained by performing a survey of the M&E before it comes in contact with radiological materials. The M&E can then be surveyed prior to leaving the area to determine the level of residual radioactivity. This works especially well for decommissioning or cleanup applications where M&E are brought into a radiologically controlled area for a limited time and a specific application. Unfortunately, there are numerous situations where pre-contact surveys are not possible.

If the M&E cannot be used as its own reference material, it is necessary to identify reference material that is representative of the M&E being investigated. Non-impacted M&E that closely resembles the impacted M&E being investigated (i.e., similar chemical, physical, and radiological characteristics) will generally be acceptable as reference material. For example, if the conceptual model shows that only surficial activity is expected, the impacted surface may be removed and the non-impacted volume used as the reference material. When similar materials are not available, the best match available should be used as reference material. It may be necessary to evaluate more than one source of reference material before an acceptable match is identified. It may be important to perform reference material surveys in areas of low ambient background. Consider M&E consisting of individual objects that are small relative to the size of the detector used to perform the measurements. When each object receives a separate measurement, the ambient background may have a larger impact on the measurement than the background contributed by the M&E itself.

As shown in Table B.1 in Appendix B, background radionuclide concentrations for materials can vary significantly. For example, concentrations for thorium series radionuclides in concrete can range from 15 to 120 Bq/kg (Eicholz 1980), so it is important to identify an appropriate reference material.

The planning team should understand that background is variable. Ambient background can change with location and over time. It may be possible to simply move the M&E being investigated to an area with a lower ambient background to improve the detection capability of a measurement method. Local conditions (e.g., temperature, barometric pressure, precipitation) can cause variations in ambient background as discussed in NUREG-1501 (NRC 1994). NUREG-1505 (NRC 1998a) Chapter 13 provides information on accounting for variability in background.

The planning team should evaluate the process knowledge from the IA and use professional judgment to identify M&E that require reference materials, and identify potential reference materials to support the disposition survey.

3.10 Evaluate an Existing Survey Design

It is not necessary to develop a new survey design for all M&E being investigated. Existing survey designs are often available for routine or repetitive applications. If an existing survey design is identified, the planning team or decision maker should evaluate the applicability of the existing design to the current investigation.

Standardized survey designs for operating facilities are often documented in the form of standard operating procedures (SOPs, see Section 4.5.1). In other cases, existing survey designs may have been developed for similar projects. A description of the M&E that can be measured should be included in each existing SOP or survey design. If the description matches the M&E being investigated, the existing SOP or survey design can be used to perform the disposition survey. If the description of the M&E is incomplete or vague, or the M&E do not match the description, a more detailed evaluation may be performed to determine the acceptability of the existing survey design.

Personnel familiar with the existing survey design and the proposed application should perform the detailed evaluation of an existing survey design. All supporting documentation used to develop the existing survey design should be available for the evaluator(s), not just the SOP or survey design being reviewed.

The detailed evaluation should determine whether the M&E are measurable using the existing survey design. If the M&E are measurable, the existing survey design can be used. Detailed evaluations should include a review of each step in the survey development process, including:

- Selection of a disposition option (Section 2.5),
- Identification of action levels (Section 3.3),
- Specification of the population parameter of interest (Section 3.4),
- Development of survey unit boundaries (Section 3.6),
- Selection of measurement methods (Section 3.8 and Section 5.9),
- Identification of alternative actions (Section 3.5), and
- Development of a decision rule (Section 3.7 and Section 4.2.6).

The results of the evaluation should be documented. The documentation may require a modification to the existing survey design. For example, the description of M&E that can (or cannot) be measured using a specific SOP may be expanded for M&E that are routinely or repeatedly surveyed. Alternatively, the documentation may consist of a notation in a survey log (including a name, title, and date) for unique items.